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PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in Detergent Briquettes and in Method of and Apparatus for Making same

I, GEORGE FRANKLYN HICKS, of 136, Bridge Road, Richmond, State of Victoria, Commonwealth of Australia, a British Subject, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to detergent briquettes, to methods of making same, and to a method of and apparatus for producing a stream of detergent solution of substantially uniform concentration using such briquettes. The invention is particularly concerned with detergent briquettes for use in dish washing machines, glass washing machines and similar apparatus in which solutions of detergent substances are employed for the wahing operations.

An object of this invention is to provide a detergent briquette of novel configuration which is eminently suitable for use in washing machines of the type in question, while another object is to provide an improved method of and means for utilising a briquette of such configuration.

According to a preferred method of utilising a detergent briquette in a washing machine, the briquette is placed in a dispenser or similar device associated with the machine and water is caused to flow over and in contact with it to produce continuously an aqueous solution containing the detergent substances of which the briquette is composed.

When the briquette is placed in the dispenser of the washing machine, and water is allowed to flow over it, it is desirable that the briquette should dissolve at such a rate as to maintain a substantially uniform concentration of detergent in the solution, and that this concentration should be maintained throughout the whole life of the briquette. Now the rate of dissolution from the surface of a solid substance, other things being equal, will depend on the surface exposed. Consequently, briquettes designed in ordinary solid geometrical shapes, such as cubes, cylinders, spheres, and the like, since their surface areas must decrease as dissolution proceeds and the size of the briquette diminishes, cannot provide a constant level of concentration in the solution througout the whole life of the block.

This can be illustrated by a simple example. If a spherical briquette of initial radius R is considered, the initial surface area will be equal to $4\pi R^2$. As the briquette dissolves away, R decreases, and the surface area decreases as a square function. Thus when R has been reduced to one-half its initial value, the surface area will have been reduced to one-quarter its initial area. It is clear, therefore, that the surface area of solid briquette decreases very rapidly as the block dissolves away, and that (other factors being equal) the concentration of detergent in the water phase must decrease rapidly as the briquette is exhausted.

I have attempted to overcome this difficulty by a method of shielding the block. The detergent block was placed in a dispenser of such design that one plane surface only of the block was exposed to the water stream, and as dissolution took place at the working surface it was intended that this should recede in a uniform manner so that the actual surface area being subject to dissolution would remain constant. However, this attempt was unsuccessful owing to certain practical disadvantages. It was found that briquettes shielded in one part, and exposed to a stream of water in another part, do not dissolve regularly and maintain a constant surface area. This appears to be due to the eroding effects of localized currents and vortices produced by the impinging water stream. After a time it was found that dissolution was

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failure to make the molded article

greatest in those places where the water stream was most rapid and the formation of vortices most extensive. This has the effect of forming irregular cavities in the block of varying shape and size, and as a result the surface area subject to dissolution varies in an unpredictable manner.

This invention involves the production of a briquette of novel shape, such that the rate of dissolution will remain substantially constant even though the volume steadily diminishes as the block dissolves away.

According to this invention I provide an improved detergent briquette having a longitudinal channel formed therein for the passage of dissolving liquid whereby the liquid may flow in contact with the inner surface of the channel and with the outer surface of the briquette, the diameter of the longitudinal channel being between one-tenth and one-quarter of the diameter of the briquette. The channel is preferably central in the briquette, and the outer surface of the briquette and the inner surface of the longitudinal channel are preferably of substantially uniform cross-section through the length of the briquette. The outer surface of the briquette and the inner surface of the longitudinal channel are preferably cylindrical in shape and coaxial with one another.

In order to provide a stream of detergent solution of substantially uniform concentration the dissolving liquid is caused to pass over a detergent briquette having a substantially cylindrical outer surface and a substantially central longitudinal channel, the liquid being caused to flow through the longitudinal channel and also over and in contact with the outer surface of the briquette. The liquid may pass firstly through the longitudinal channel and secondly over the outer surface of the briquette, or *vice versa*, but inasmuch as it is desirable to prevent the accidental bypassing of the water stream, the direction of flow first stated leads to simpler design and operation of the apparatus. As the process of dissolution proceeds the surface area of the longitudinal channel will increase while the surface area of the outer surface of the briquette will decrease, the one tending to compensate the other. By a suitable selection of the initial dimensions of the longitudinal channel and of the briquette in relation to the rate of liquid flow, it will be shown that a substantially constant rate of dissolution can be secured throughout the whole effective life of the briquette.

The actual outer shape of the briquette is, within limits, a matter of convenience, but for simplicity in the manufacture of the briquette and in the design of the apparatus, the most convenient form consists of a briquette of cylindrical shape with a central orifice in the form of a coaxial cylinder.

To examine the effect of dissolution of a briquette of this type, a cylindrical briquette of length L and outer radius R, having a coaxial cylindrical orifice of radius r, may be considered. Dissolution cannot, of course, occur at the end on which it rests, and it has been found that the amount of dissolution occurring at the upper end is relatively insignificant. For a close approximation, therefore, only the cylindrical surfaces need be considered.

Area of outer cylindrical surface: $2\pi RL$

Area of inner cylindrical surface: $2\pi rL$

$\therefore$ Total surface of dissolution: $2\pi L(R+r)$

Other things being equal, the rate of dissolution will be proportional to the surface area at which dissolution is taking place. The rate of dissolution will therefore remain constant if the surface area of dissolution remains constant, which will occur if the expression $(R+r)$ remains constant. A rate of dissolution which is proportional to the surface area of dissolution implies that, after a given time, the surface will have been eroded uniformly to a certain depth. Let this depth of erosion be d in the present instance. Then after the given time interval, and to a first degree approximation:—

R will have decreased to $R-d$

r will have increased to $r+d$

Hence the new surface of dissolution will have become:—

$$2\pi L\ (R-d+(r+d))\ =2\pi L\ (R+r)$$

It is clear, therefore, that to a first approximation, the surface area of dissolution, and hence the rate of dissolution, will remain constant.

The above calculation, however, presupposes that the rate of dissolution is proportional to the surface area of dissolution. This would appear to require that the conditions operating throughout the whole surface of dissolution should be substantially uniform. This appears doubtful in view of the fact that the velocity of the water stream up the central channel must exceed its velocity when flowing down the outer surface, and that the rate of dissolution into pure water near the entry nozzle probably differs from that into the already partially saturated solution later on. Hence the above conclusion regarding the proportionality of rate of dissolution to surface area of dissolution requires substantiation by investigation of practical systems.

Such an investigation has been carried out and indicates that, provided the rate of water flow does not exceed a certain high critical value related to the Reynolds Number, the rate of dissolution from briquettes of this type is substantially constant throughout their whole life. This is illustrated by the example illustrated graphically in Figure 1 of the accompanying drawings. In this example a detergent briquette fabricated in the manner above described lost weight regularly until over 90% had been consumed. At that stage it had been reduced to a cylindrical wafer, but still the rate of dissolution remained substantially constant, and fell off only when the structure finally collapsed. The constancy of the detergent concentration in the aqueous solution is also shown.

The fact that the rate of dissolution is substantially independent of the rate of flow of the water leads to the conclusion that, under normal conditions of water flow, the rate of dissolution is primarily determined by the dimensions and composition of the briquette.

In addition, since the rate of dissolution is independent of the flow of water, it follows that, for a given type and composition of briquette, the concentration of dissolved detergent in the aqueous solution is inversely proportional to the rate of water flow. This fact, which affords a simple means of controlling the concentrtion of detergent in the aqueous solution, is illustrated graphically in Figure 2. That the varying of the rate of flow from 10 to 18 gallons per hour has had no observable effect on the rate of dissolution of the block is shown by the even slope of the curve representing the weight of the briquette. That the concentration of the detergent in the aqueous solution has varied inversely as the rate of flow is clearly indicated by the concentration curve.

In order to manufacture a detergent briquette for a given purpose it is first necessary to choose its composition so that it will possess the necessary detergent power and its rate of dissolution will be of the correct order of magnitude. The size of the briquettes should then be computed from the quantity required to last for a normal working period. Having determined the size, and assuming the cylindrical shape has been adopted, it is then necessary to determine the dimensions. In determining the dimensions, compactness is a major consideration, and I have found that a cylindrical briquette with a height equal to twice the diameter, is very convenient, although other dimensions may be more suited to specialised uses. The initial size of the central orifice may be varied over a wide range, but if it is too small the resultant initial water flow in this region may exceed the critical rate, while if it is too large it detracts from the strength and compactness of the block. A suitable compromise depends on the intended rate of water flow, but I have found that a ¾-inch orifice gives satisfactory results. The diameter of the central channel is between one-tenth and one-quarter of the diameter of the briquette.

I have obtained satisfactory results with a cylindrical briquette 4-ins. in external diameter and 8-ins. in height, having a coaxial cylindrical orifice ¾-in. in diameter, but it will be appreciated that the exact dimensions of the orifice and the external diameter of the briquette are in no way critical to this invention, provided that they fall within the ratio specified above. Having fabricated a briquette of these or other suitable dimensions, it is tested in apparatus such as that hereinafter described for rate of dissolution and concentration of detergent solution produced. As has been pointed out the concentration of the detergent solution may be varied, within the limits imposed by the process, by varying the rate of water flow. If, at a first test, the rate of dissolution is not sufficient to produce the detergent concentration desired, then slight adjustments to the composition of the briquette can be made until a satisfactory result is achieved.

In the production of detergent briquettes of the type described in this patent application, I have found that the moulding or casting of such briquettes can be satisfactorily effected by employing a mould and core made from a resilient material, so that the expansion of the liquid mass during solidification can be accommodated without local increase in pressure. A further feature resides in the fact that such a mould is sufficiently flexible to be stripped from the moulded product.

I have achieved these desiderata by employing moulds and cores manufactured from rubber, synthetic rubber, resilient plastics, or similar flexible, resilient, rubber-like materials.

Reference will now be made to the apparatus illustrated in Figures 3 to 8 of the accompanying drawings. In these drawings:—

Figure 3 is a view in sectional elevation of an apparatus for producing a detergent solution, and of a detergent briquette formed according to this invention and shown in such apparatus.

Figure 4 is a perspective view of the briquette.

Figure 5 is a perspective view of apparatus used to form the briquette.

Figure 6 is a perspective view of the flexible mould.

Figure 7 is a perspective view of the base of the mould, and

Figure 8 is a perspective view of the mould core.

Referring to Figure 3, the cylindrical briquette 10 is shown mounted within the casing 11 of a dispenser 12 and is supported on an apertured plate 13. An inlet pipe 14 and outlet pipe 15 are fitted in the bottom of the dispenser, the inlet pipe 14 communicating with the lower end of the central channel 16 in the briquette 10 and the outlet pipe 15 communicating with a compartment 17 below the plate 13. The compartment 17 communicates with an annular space 18 between the casing 11 and the outer cylindrical surface of the briquette.

When the dispenser is in operation water flows from the inlet pipe 14 upwardly through the central channel 16 in the briquette 10, over the top of the briquette and then downwardly over the outer surface of the briquette to the outlet pipe 15. By this arrangement a detergent solution of substantially constant concentration is produced during almost the full life of the briquette.

Referring to Figures 4 to 8, the briquette of this invention is preferably cast or moulded in an apparatus such as that illustrated in these Figures. This apparatus comprises a cylindrical mould 20 formed of rubber or other resilient material, which mould is tubular and is divided longitudinally at one point as shown at 21. The mould 20 is adapted to be mounted in a cylindrical cavity formed in a case 22 of wood or like material, which case is formed in two parts hinged together. When the parts of the case 22 are closed the rubber mould fits neatly therein with the division 21 of the mould closed. A disc-shaped base 23 of rubber or like material fits into the bottom of the cavity in the case 22 below the mould 20. A central hole 24 is formed in the base 23. A core 25 of rubber or other elastic material is mounted centrally in the cavity with its lower end held in the hole 24 and its upper end held in a clamp 26 secured to a bracket 27 mounted on the case 22.

In casting a detergent briquette the apparatus is assembled as shown in Figure 5, and the detergent mass in liquid or semi-liquid form is poured into the mould 20 and around the core 25 and allowed to solidify. When the briquette has cooled and solidified, the case 22 is opened and the mould 20, briquette 10 and core 25 removed therefrom. The mould 20 may be removed from the briquette by a peeling motion commencing at the division 21, and the base 23 is also removed. The flexible core 25 is then stretched slightly, which has the effect of reducing its diameter, when it can be readily withdrawn from the briquette.

The detergent briquette thus formed has an outer cylindrical surface, and an inner centrally disposed cylindrical cavity, as shown in Figure 4, and is capable of use in dispensers of washing machines and the like so as to produce a detergent solution having a substantially uniform concentration.

What I claim is:—

1. A detergent briquette having a longitudinal channel extending therethrough whereby dissolving liquid may flow in contact with the inner surface of said channel and with the outer surface of the briquette, the diameter of the longitudinal channel being between one-tenth and one-quarter of the diameter of the briquette.

2. A detergent briquette according to Claim 1 and having a substantially cylindrical outer surface and a substantially cylindrical channel extending longitudinally and centrally through the briquette, whereby on flowing a dissolving liquid in contact with the outer cylindrical surface of the briquette and with the inner cylindrical surface of the longitudinal channel the briquette is dissolved at a substantially uniform rate during the majority of its life.

3. A method of producing a detergent briquette according to Claim 2 which comprises pouring a liquid or semi-liquid detergent mass into a cylindrical divided mould of resilient material, a cylindrical core of resilient material being disposed centrally and longitudinally in the mould, allowing the mass to solidify, peeling the resilient mould from the outer surface of the cast briquette, stretching the resilient core and removing it from the central longitudinal channel formed in the briquette.

4. A method of producing a stream of detergent solution of substantially uniform concentration which comprises flowing the dissolving liquid over a detergent briquette having a substantially cylindrical outer surface and a substantially central longitudinal channel, the liquid being caused to flow through the longitudinal channel and also over and in contact with the outer surface of the briquette.

5. A method according to Claim 4, wherein the liquid is caused to flow in one direction through the longitudinal channel and in the opposite direction over the outer surface of the briquette.

6. A method according to Claim 4 wherein the liquid is caused to flow firstly through the longitudinal channel and secondly over the outer surface of the briquette.

7. A method according to Claim 4 wherein the liquid is caused to flow firstly over the outer surface of the briquette and secondly through the longitudinal channel.

8. Apparatus for producing a detergent solution of substantially uniform concentration which comprises a casing, a detergent briquette mounted in the casing, the briquette being formed according to Claim 1 or Claim 2, and means for flowing dissolving liquid through the longitudinal channel and over the outer surface of the briquette.

9. Apparatus according to Claim 8 and having an inlet pipe which communicates with one end of the longitudinal passage in the briquette, the liquid being caused to flow through said channel and then between the outer surface of the briquette and the wall of the casing, and an outlet pipe for withdrawing the liquid from the casing.

10. Apparatus for producing a cast detergent briquette formed according to Claim 1 or 2 which comprises a tubular mould of resilient material which is divided longitudinally at one point, and a core of resilient material disposed longitudinally in the mould.

11. Apparatus according to Claim 10 wherein the mould and core are cylindrical, and having a substantialy rigid outer case in which the mould is supported, the outer case being partible to facilitate insertion and removal of the mould, and means on the outer case for supporting the core longitudinally in the mould.

12. A detergent briquette substantially as hereinbefore described with reference to Figure 4 of the accompanying drawings.

13. A method of producing a detergent briquette substantially as hereinbefore described.

14. A method of producing a stream of detergent solution of substantially uniform concentration, substantially as hereinbefore described.

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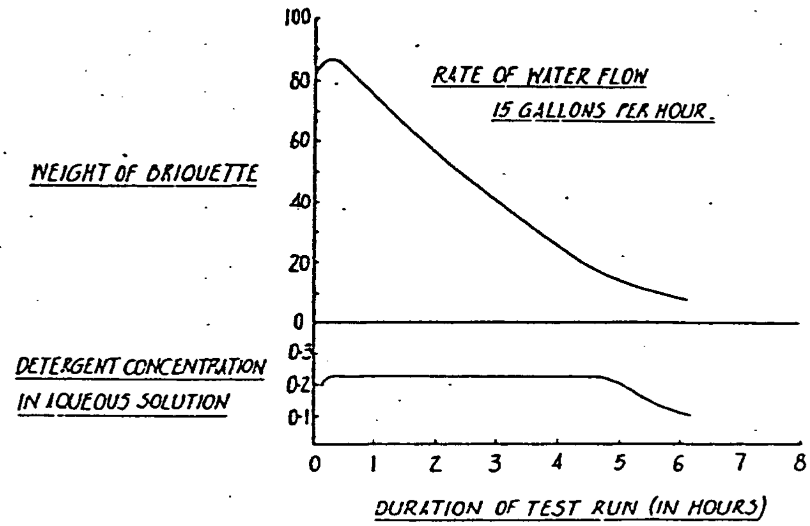
RATE OF WATER FLOW
15 GALLONS PER HOUR.
WEIGHT OF BRIQUETTE
DETERGENT CONCENTRATION
IN AQUEOUS SOLUTION
DURATION OF TEST RUN (IN HOURS)

FIG. 1.

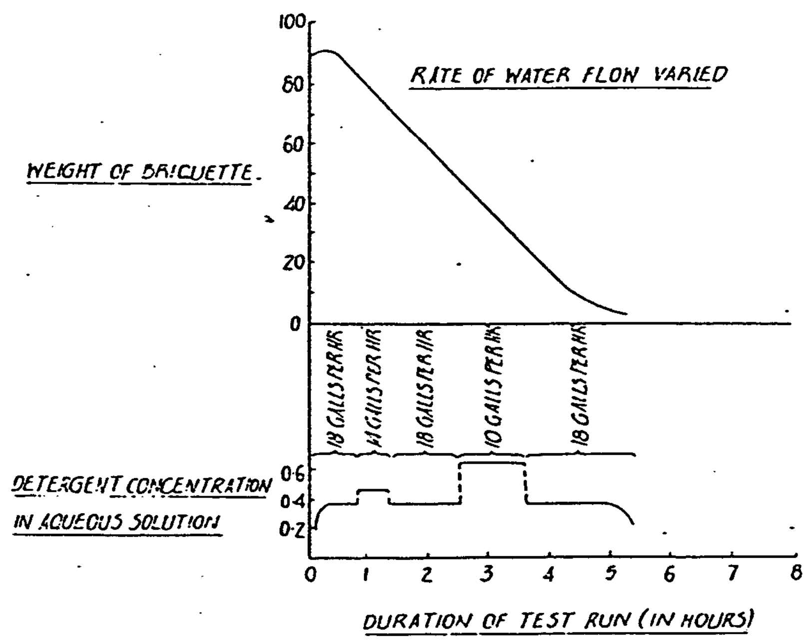
RATE OF WATER FLOW VARIED
WEIGHT OF BRIQUETTE.
18 GALLS PER HR
10 GALLS PER HR
DETERGENT CONCENTRATION
IN AQUEOUS SOLUTION
DURATION OF TEST RUN (IN HOURS)

FIG. 2.

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2 SHEETS

This drawing is a reproduction of the Original on a reduced scale.

SHEETS 1 & 2

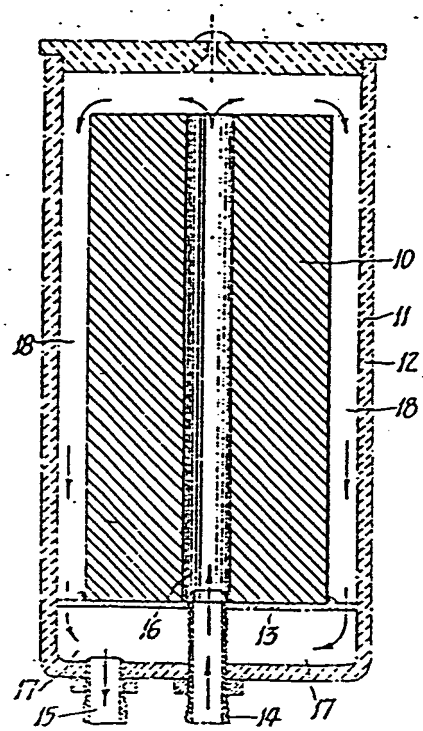

FIG. 3.

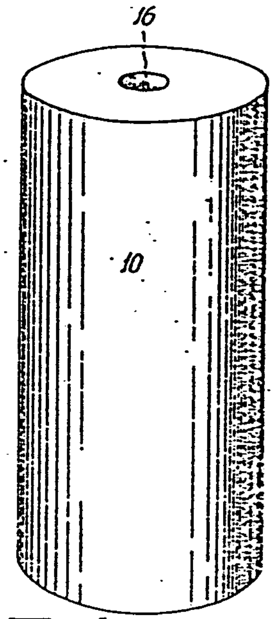

FIG. 4.

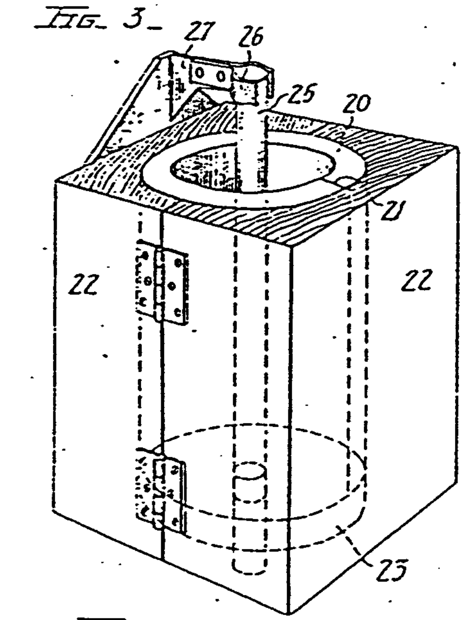

FIG. 5.

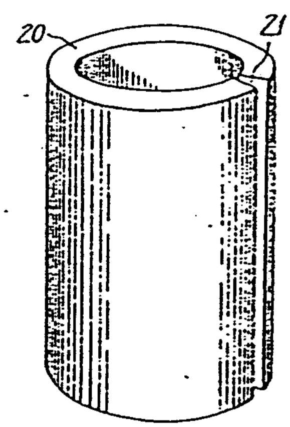

FIG. 6.

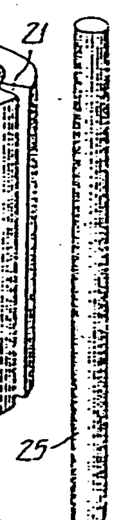

FIG. 8.

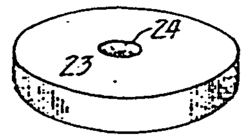

FIG. 7.